

PROGRESS REPORT NO. 8

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THE PROBLEM OF MAN'S GRAVITOINERTIAL FORCE ENVIRONMENT IN
SPACE FLIGHT

Submitted to NASA, Biotechnology and Human Research Division, Office of Advanced
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By

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Period Covered

1 January 1965 - 31 March 1965

The highlight of the period under review was the symposium on, "The Role of the Vestibular Organs in the Exploration of Space" sponsored by the Office of Advanced Research and Technology with the School of Aviation Medicine at Pensacola acting as host. In his opening remarks, Dr. Walton Jones stated that the "vestibular problems posed by manned space flight --- appear to fall into two main categories, namely, the prevention of vestibular disturbances in weightlessness and the possible need to generate artificial gravity. The disturbing symptoms experienced in weightlessness require much detailed study. We are convinced that we will solve these problems; but, we will not be absolutely sure until we have conducted some experiments in orbit under the weightless condition for considerable time."

"The second problem arises out of the possibility that artificial gravity will be needed. This is not the place to debate the pros and cons of this possibility but for you to tell us what provisions should be made if the need eventuates. In orbiting spacecraft, a constant level of artificial gravity can be provided only by the generation of centripetal force either by rotation of the entire spacecraft^{or} by what amounts to a human centrifuge. It would seem as if we must make provision for either or both if we keep in mind the requirement for fitness aloft and the greater requirement for fitness on re-entry. The two mutually dependent problems requiring solution are how much artificial gravity is needed and how does one prevent any undesirable side effects."

"From the standpoint of those charged with the responsibility of ensuring that the problems are solved, the question arises as to how best this can be accomplished, keeping in mind time-stress and, contrary to what people think, dollar-stress. I am hopeful that additional guidelines will appear out of the deliberations of this symposium. Indeed, it will be a disappointment to me if this is not the case. Although we have a firm appreciation of your desire and need for basic background information, we request that you generate the same appreciation for our need to furnish specific engineering data at specific points in time."

Thirty-three papers were read and one additional report in the Proceedings was "read by title." These papers fell into three main categories, namely, background studies and those dealing with weightlessness and rotating environments. Topics in the first category included: 1) the fine structure of the vestibular organs and its significance for function, 2) the response characteristics of the semicircular canals and otolith organs, 3) certain inter-relationships of the two vestibular organs, and 4) central nervous system mechanisms influencing vestibular response and brief treatment of useful purposes and clinical aspects. Papers on weightlessness emphasized the effects of deafferentation of the otolith apparatus and its possible significance during prolonged exposure. Reports dealing with the rotation environment began with a discussion of the physical forces generated by the combined motions of vehicle and man. Agreement was not reached regarding the forces responsible for stimulating the semicircular canals. The importance of this disagreement was recognized in our need to go back to

the physical stimulus as the basic point of departure in all investigations. An unusual amount of interest was shown in pointing out the limitations of earthbound rotating rooms in simulating conditions in orbiting rotating spacecraft. Recent findings reported on included the effects of prolonged exposure, the use of countermeasures including stepwise increase in velocity, and the use of drugs.

The entire proceedings of the symposium have been edited and forwarded to OART for publication. In the Preface it was stated that, "The striking feature of this (present) symposium was not the presentation of facts, important though they were, but the enthusiasm of the participants. This spirit, unfortunately, cannot be captured from a reading of the proceedings. Nor can the proceedings reflect adequately either the great scope of the investigations now underway or the numerous problems still awaiting investigation. Rather, the proceedings might be regarded as a series of vignettes, usually reportorial but sometimes polemical in nature, contributing only a limited number of restricted views of the entire picture."

Investigators attending the symposium were benefited by the opportunity to review and discuss important theoretical aspects and practical problems having their genesis in the vestibular organs. Those having responsibility for sponsoring and monitoring vestibular research had the opportunity to: 1) learn more about the difficulties in studying the vestibular organs, 2) the complex relationship between the semicircular canals and otolith organs and the almost incredibly complex stimulus response mechanism in unusual force environments, and 3) the great gaps in our knowledge which must be filled.

Facilities

The move into the new School complex has begun. The fact that the vestibular annex is not completed and the need to vacate the "old" laboratory spaces has necessitated establishment of temporary laboratories.

Personnel

There have been no major changes in staffing.

Visitors

Dr. Martin Bergstedt, Umea University, Sweden

Dr. Bo E. Gernandt, Gothenburg, Sweden

LTCOL Edward C. Knoblock and Dr. Walter Mertz of Walter Reed Army Institute of Research participated in the joint NAVY-NASA-ARMY experiment conducted in the new Slow Rotation Room.

Dr. T. G. Hiebert, Chicago, Ill. spent two weeks active duty participating in a research project.

Completed Reports

(List attached)

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67. Niven, J. I., Hixson, W. C., and Correia, M. J., An experimental approach to the dynamics of the vestibular mechanisms.
68. Graybiel, A., and Gregly, A. R., A new quantitative ataxia test battery.
69. Clark, B., and Graybiel, A., Some factors contributing to the delay in the perception of the oculogravic illusion.
70. Johnson, W. H., Money, K. E., and Graybiel, A., Some vestibular responses pertaining to space travel.
71. Miller, E. F., II, and Graybiel, A., Otolith function as measured by ocular counterrolling.
72. Guedry, F. E., Jr., Comparison of vestibular effects in several rotating environments.
73. Colehour, J. K., Stress measurements in normal and labyrinthine defective subjects.
74. Igarashi, M., Histopathology after experimental saccular destruction in the squirrel monkey.
75. Eskin, A., and Riccio, D. C., Changes in spontaneous activity as a measure of sensitivity to rotation in the white rat.
76. Fregly, A. R., Bergstedt, M., and Graybiel, A., Some relationships between blood alcohol, positional alcohol nystagmus (PAN), and postural equilibrium (ataxia).
77. Wood, C. D., Graybiel, A., McDonough R., and Kennedy, R. S., Evaluation of some anti-motion sickness drugs on the Slow Rotation Room (No. 1).
78. Guedry, F. E., Jr., Habituation to complex vestibular stimulation in man: Transfer and retention of effects from twelve days of rotation at 10 RPM.
79. Igarashi, M., McLeod, M. E., and Graybiel, A., Clinical pathological correlations in suppression of semicircular canal function by streptomycin sulfate.

*Serial numbers.